opinion as to what the subsequent reactions may be."[1] Subject to what may be said of particular instances or occasional exceptions, the statements made by me as to the result of many years' observation and experiment of others and myself are on the whole practically accepted. Probably Mr. Stead is correct when he assumes that the dissolved iron sulphide is resolved into calcium sulphide, and iron oxide, as by the Saniter process, or in the blast furnace, by the excess of lime in solution in the slag.

In this connection, as regards the blast furnace, heat plays a double part, firstly for the intensification of the chemical affinity of sulphur for the alkaline base (lime, of the slag; secondly, for the adequate liquefaction of this highly basic slag, overcharged with lime and requiring a high temperature for its perfect fusion, which otherwise would remain in and clog up the blast furnace, thus obviously checking the proper working of the furnace and the uniform descent of the materials charged above.

Phosphorus is apparently not eliminated in sensible quantities under the above conditions. Practically the whole is retained and passes into the pig iron. Blast furnace slags are, however, never quite free from phosphorus, and some species of the latter contain sensible quantities, the amount depending on the excess of phosphorus present in the ores, and the working conditions. Usually such slags contain an excess of iron oxide as compared with ordinary grey iron slags, the latter being generally free from iron oxide or, at any rate, the amount does not exceed ½ per cent. in good slag.

Metallurgical experts have for some time been engaged in devising methods for the removal of sulphur. It is needless here to recapitulate in detail the very many processes tried by them, and for the most part abandoned. All are based on the use, in one way or another, of alkaline or basic materials. However, the experience thus acquired seems to have been utilised, and has led to valuable tangible results, for of late several processes have been worked out with some degree of success, but in our opinion there is still room for improvements, both in cost and general efficiency. In addition, the time and trouble involved in these processes ("which may be classified as methods of secondary purification," *i.e.* methods by which the iron is to some extent freed from sulphur after its production in the blast furnace) are important items seriously impeding further progress. It really seems that the proposed methods of secondary purification may ultimately prove too tedious and expensive, the limit betwixt loss or gain being just now very small. Recognising this, attempts have been made to cheapen the processes, all, however, based on the use of alkaline or basic material, but so far it appears the results are somewhat uncertain.

Mr. Saniter's lime and calcium chloride method, "one of the first recently proposed and tried," has been worked, as the writer can testify, with some success, but the costs, by general consent, are considered somewhat heavy. It is only fair to say that the inventor is not of this opinion, and he quotes reasons to the contrary which should be well weighed before a final opinion is held as to the merits of this process. Secondary processes must from their very nature be costly and troublesome when dealing with the production of thousands of tons of metal continuously flowing from the blast furnace throughout the year.

The earlier attempts to purify crude iron from sulphur, &c., merely paved the way for recent developments, and, on the whole, merely suffice to prove that alkaline or basic substances only can effectively be used. It is now generally admitted that lime is the only base which can be applied with anything approaching economic results, and the methods now being practised have resolved themselves into endeavours to use this reagent efficiently and economically. Manganese as another reagent is an effective desulphuriser, but this requires to be separately investigated.

Lime is, and always has been, used in the blast furnace for the elimination of sulphur from iron; and it is well known that a non-sulphury pig-iron cannot be manufactured unless an excess of lime be charged into the furnace over and above the lime required for the formation of a fluid slag or lime silicate. It is evident, however, that the use is limited owing to the infusibility of the basic slags formed. These are facts which need no further comment, as they are universally acknowledged on all sides. If some modification could be introduced into ordinary blast furnace charging whereby this infusible slag containing an excess of lime could be continuously cleared out of the furnace, we should have at our command a continuous *direct* method of eliminating sulphur from iron at a minimum expenditure, and at a great saving in the time and labour involved in the processes of purification.

John Parry.

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[1] Stead, Iron and Steel Institute.

THE METEOROLOGICAL OBSERVATORY ON BEN NEVIS.

THE Directors of the Ben Nevis Meteorological Observatory have prepared a guide book which will be of great use to the tourist who desires to scale the top of the Ben and feast his eyes upon the crag and mist beneath, and also to the large number of people interested in meteorology. By the kindness of the publishers (Messrs. John Menzies and Co., Edinburgh and Glasgow) we are able to give three illustrations of the Observatory, with an account of its foundation and the work carried on there. For many years it has been recognised that the best means of obtaining definite information as to the vertical variation of atmospheric conditions was to establish meteorological stations differing considerably in altitude but in the same locality. In this connection we read that "in 1877 Mr. Milne Home, then Chairman of the Council of the Scottish Meteorological Society, pointed out the singular advantages of Ben Nevis as a high-level station. It is the highest mountain in the British Islands (4406 feet); its summit is, in horizontal distance, about four miles from a sea-level station at Fort William, and is situated in the track of the south-west storms from the Atlantic, which exercise such a preponderating influence on the weather of Europe, especially in autumn and winter. Its advantages are therefore unique, and observations made there have proved to be of the greatest interest and value to meteorology."

Unfortunately, though a plan of an observatory was prepared by the late Mr. Thomas Stevenson in 1879, for the Scottish Meteorological Society, the work could not be proceeded with for want of the necessary funds. From June to October, 1881, however, Mr. Clement L. Wragge made observations at the summit simultaneously with Mrs. Wragge at Fort William, and an elaborate series of simultaneous observations at different heights on the mountain were successfully made in the two following years. The discussion of these observations led to very important results, and was the means of exciting the interest in the public mind essential to the obtaining of subscriptions. An appeal for funds to enable an observing station to be erected was promptly responded to, a sum of £4,000 being soon collected. A feu of an acre of land was obtained on the top of the mountain from Mrs. Cameron Campbell, of Monzie, and upon it an observatory was erected from plans by Mr. Sydney Mitchell. "The observatory was opened by Mrs. Cameron Campbell on October 17, 1883. Observations were begun in the following month, and have been carried on ever since. At the same time a sea-level station was opened at the public school, Fort William, under charge of Mr. C. Livingston, where comparison readings were taken five times a day with great punctuality and accuracy. But a few years showed the necessity of having a continuous record at sea-level as well as on the summit, and in 1889 the directors resolved to carry out the original plan which want of funds had hitherto prevented, and set up a low-level observatory. Aided by a grant from the Edinburgh Exhibition of 1886 and contributions from the public, they were able to erect a suitable building close to sea-level, on ground feued from Mr. Cameron, of Lochiel, in the beginning of 1890. The Meteorological Council of London equipped this station with self-recording instruments, and increased their annual grant to the directors from £100 to £350. Observations began in the middle of July, 1890, and since then there has been a continuous record of barometric pressure, temperature, humidity, rainfall, &c., by day and by night, both on the summit of Ben Nevis and at sea-level. The distance between the high and low-level observatories is only 4¾ miles, and their heights above sea-level respectively 4407 and 42 feet. Mr. Livingston also continued his observations for a year after the commencement of the low-level observatory, so that there might be a satisfactory comparison of the two sea-level stations. The telegraph wire from the summit has been extended to the low-level observatory, and the observers can communicate with each other at any time, and reports from both stations are sent daily to the newspapers. The high and low-level stations are worked as one observatory, the observers being interchangeable, and the low-level serves also as a depôt for stores, &c., which are carried up during the summer to the top." The original buildings on the hill-top were found too small for satisfactorily carrying on the work of the observatory, so in the summer of 1884 large additions were made, the most important being the erection of a tower about thirty feet high, which serves the double purpose of carrying a set of anemometers and of providing a convenient exit when the winter snows have closed the ordinary doorway.

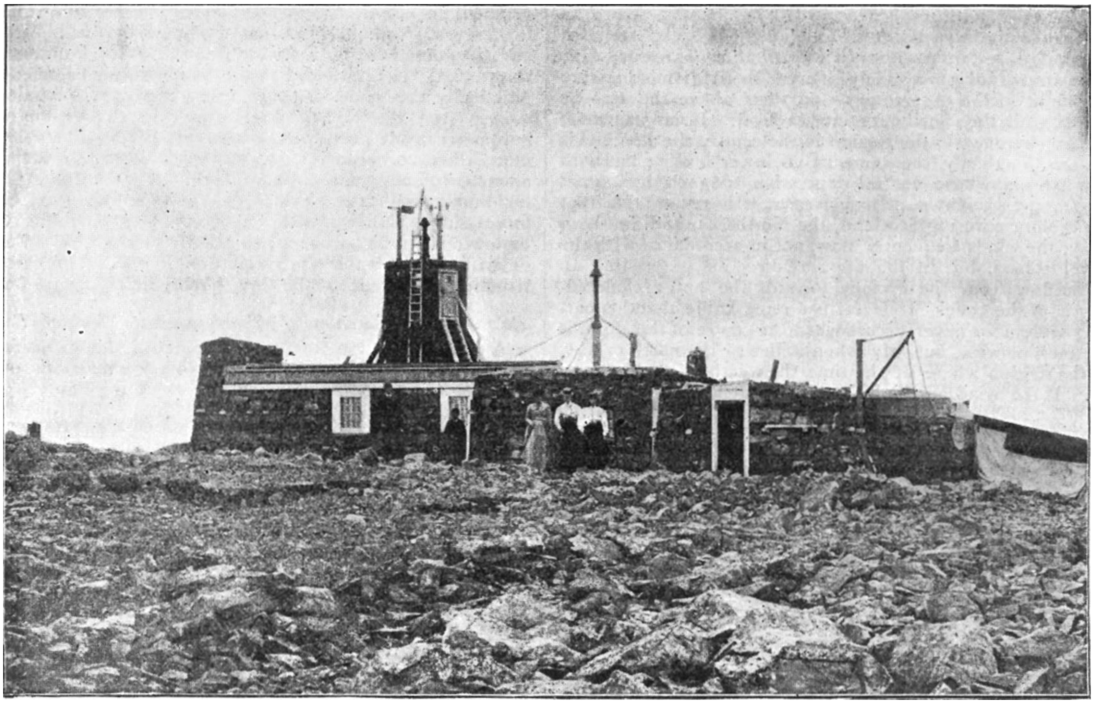

FIG. 1.—The Observatory in Summer.

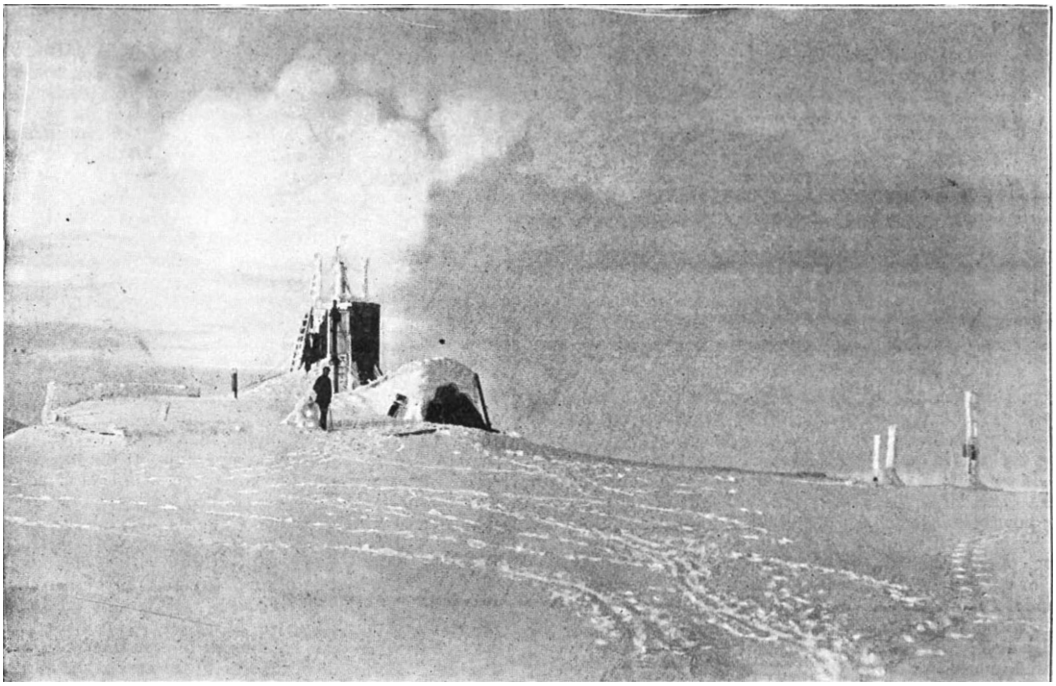

FIG. 2.—The Observatory in Winter.

The Winds of Ben Nevis.

In addition to the routine work, other observations and researches have been carried on by the observers on Ben Nevis.

"An exhaustive examination of the 'Winds of Ben Nevis' has been made by Messrs. Omond and Rankin, and the results published in the 'Transactions of the Royal Society of Edinburgh.' It is shown that while the sea-level winds in this part of Scotland are, with respect to the distribution of pressure, in accordance with Buys Ballot's 'Law of the Winds,' the Ben Nevis winds do not fit in with such a distribution of pressure, but, on the contrary, point to a widely different distribution of pressure at the height of the observatory—4407 feet above the sea—as compared with the distribution at sea-level. In large storms, with a deep barometric depression in the centre, the Ben Nevis winds are practically the same as at lower levels; but with smaller storms, whose central depression is much less, great differences are presented. In such cases it is remarkable that with a cyclone covering Scotland, the North Sea, and Southern Norway, the winds frequently blow, not in accordance with the sea-level isobars, but in the opposite direction, suggesting an upper outflow from the cyclone towards the anti-cyclone adjoining it at the time. It is further remarkable that this outflowing seldom or never occurs when the centre of the storm is to the south or west, but only when it lies to the north or east, or in the region where at the time the weather is coldest and driest. If the wind on the hill-top is not at a right angle or a greater angle from the sea level wind, it is usually nearly the same as it. The supposed veering of the wind at great heights—required by the theory that a cyclone is a whirling column, drawing the air in spirally below and pouring it out spirally above—is so seldom observed as to be the exception, and not the rule. This important result, and the analogous observation that frequently in great storms of winds prostrate trees lie practically in one direction over wide regions, show impressively how much observation has yet to contribute before a satisfactory theory, or even a merely correct description of storms can be propounded.

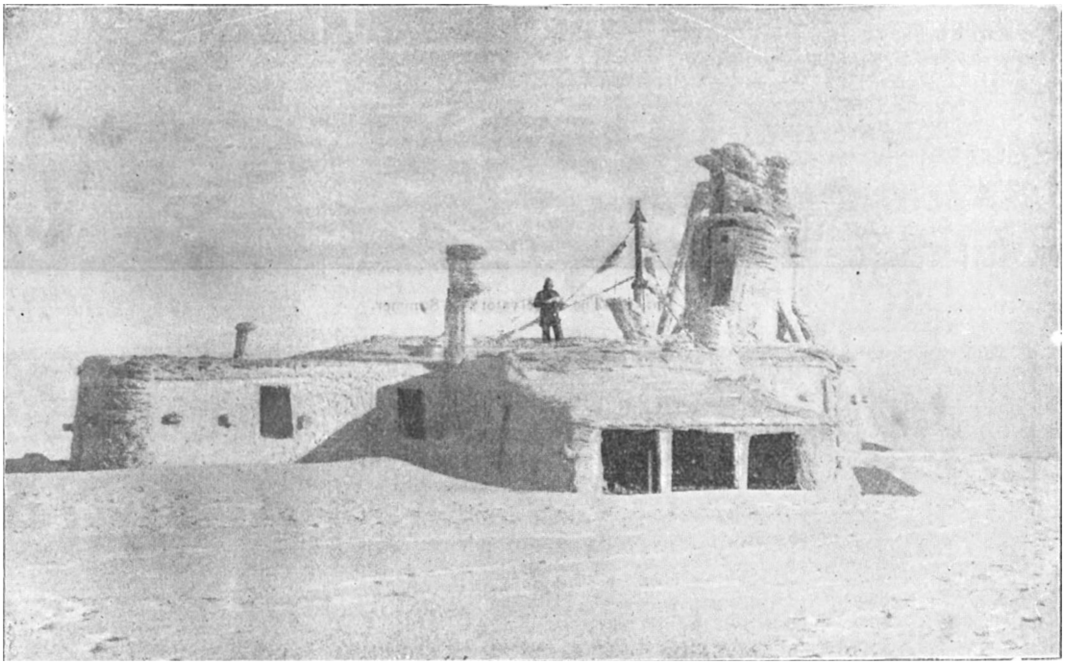

FIG. 3.—Observatory covered with Fog Crystals—an Observer at Work.

"The winds at Säntis, Puy de Dôme, and other high-level European observatories, which may all be practically regarded as situated in anti-cyclonic regions, have been examined, and it is found that they show the closest agreement with the winds at low levels in the same regions. This result separates the Ben Nevis Observatory from other observatories, constituting it a class by itself, the differentiating cause being the circumstance that Ben Nevis alone lies in the central track of the European cyclones. This consideration emphasises the value of the Ben Nevis observations in all discussions of weather and atmospheric movements. It may be added that, with respect to the relation of the winds to the low-level isobars, Ben Nevis Observatory is more pronouncedly a high-level observatory in winter than in summer, or, more generally, in cold than in warm weather."

The influence of high winds upon barometric pressure has also been investigated. A comparison of readings of the barometer and anemometer at both the high and low level observatories shows that "in calm weather the two reduced barometers are practically the same, but with every increase of wind which sweeps past the higher observatory the depression of the barometer inside steadily augments. It is not till a velocity of more than 20 miles an hour is reached that the depression amounts to one-hundredth of an inch. At 57 miles it is 0·050 inch, at 77 miles 0·104 inch, and at 99 miles 0·150 inch. In forecasting weather it will be necessary to keep this effect of high winds on the barometer constantly in mind, with the view of arriving at a better approximation to the geographical distribution of pressure at the time the forecasts are being framed."

Relation of Differences of Temperature to those of Pressure.

A discussion of the differences between simultaneous readings of pressure and temperature at the two observatories shows that "during the period of occurrence of an anti-cyclone, when the temperature at the top of the mountain, with reference to that at Fort William, is highest, the pressure at the top, reduced to sea-level, is 0·047 inch higher than at Fort William; and, on the other hand, when the temperature at the top is very greatly lower than the average as compared with that at Fort William, the pressure at the top, reduced to sea-level, is 0·029 inch lower than that at Fort William. There is, therefore, a mean difference of 0·076 inch of pressure for these two distinct types of weather. The broad result is this, and it is clear and explicit, that when the higher observatory has the higher temperature, and also when the differences of temperature are small, then the reduced pressure at the top of the mountain is the greater of the two; but when the differences of temperature are large, then the reduced pressure at the top is the lesser of the two. . . . The result, which is altogether unexpected, raises questions of the greatest importance, affecting the theory of storms, the effect of vertical movements of great masses of air on the barometric pressure which accompanies cyclones and anti-cyclones, and the necessity there is for some accurate knowledge of the absolute amounts of aqueous vapour at different heights in the atmosphere under different weather conditions, and how this knowledge may be arrived at from the readings of the dry and wet bulb thermometers under different atmospheric pressures. Ben Nevis, with its two observatories, one at the top, the other at the foot of the mountain, would, with a third half-way up the hill, afford unique facilities for the prosecution of this all-important hygrometric inquiry, which would, however, require considerable additions, for the time it is carried on, to the observatories' present appliances and staff."

St. Elmo's Fire and Thunderstorms.

"Cases of St. Elmo's Fire are not infrequent occurrences on Ben Nevis. The cases observed have mostly occurred during the night, and during the winter months from September to February. A careful discussion of these cases shows that the weather which precedes, accompanies, and follows has quite peculiar characteristics not only on Ben Nevis but also over the West of Europe generally; indeed, so well marked is the type of weather, and so notorious is it for its stormy character, that it is familiarly known at the observatory as 'St. Elmo's weather.' It is further observed that in almost every case another cyclone, with its spell of bad weather, follows the particular cyclone on the south-eastern side of which St. Elmo's Fire is observed.

"The winter thunderstorms are observed under the identical weather conditions under which St. Elmo's Fire occurs; that is, they invariably occur on the south-east side of the cyclone's centre, with the easterly passage of which they appear to be intimately connected. The thunderstorms and cases of sheet-lightning of Ben Nevis are essentially autumn and winter occurrences, 70 per cent. of the whole having occurred from September to February."

Electric Currents.

"Prof. C. Michie Smith has shown that on the edge of a dissolving mist the potential is lower than the normal, but higher on the edge of a condensing mist. Now, almost always when the top of Ben Nevis becomes clear for a short time, a strong current comes up the telegraph cable, while as soon as the summit is again enveloped the current is reversed. The connection between the moisture of the atmosphere and the earth currents is still further shown by the rainfall. During a fall of rain or snow the current nearly always passes down the cable; and in the case of a sudden shower the current has sometimes driven the mirror of the galvanometer violently off the scale. A cessation of the rain or snow generally has an exactly opposite effect. If it be assumed that the summit of Ben Nevis takes the potential of the masses of vapour covering it, and if we consider the earth-plate at the base as the earth, or zero of potential, it is obvious that the results confirm the theory advanced by Prof. Michie Smith, a conclusive proof of which would be of the greatest importance in investigations connected with thunderstorms."

Dust Particles in the Atmosphere.

Observations of the numbers of dust particles in the atmosphere have been made by means of the dust-counting apparatus devised by Mr. John Aitken in 1889. The results show a well-defined diurnal period, the number of particles being above the average in the afternoon, and below it in the morning.

"From the whole of the observations on Ben Nevis, the mean is 696 per cubic centimètre, the maximum being 14,400, while on several occasions the minimum fell to 0. In a large number of observations made by Mr. Aitken at Kingairloch, on the west shore of Loch Linnhe, the average number was 1600 particles per cubic centimetre; in London he found, on one occasion, 100,000, and this number was exceeded in Paris."

Many other investigations of a high scientific value have been made by the Ben Nevis observers, and the observations have furnished matter for discussion to a number of meteorologists. But though much has already been done, it is evident from the reports issued by the directors of the observatory from time to time that still more important results can confidently be expected.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE seventh session of the Edinburgh summer meeting ended on Saturday. As regards number of students and scope of studies this meeting is still on the increase. Among the scientific courses may be noticed contemporary social evolution, by Prof. Patrick Geddes, comparative psychology by Prof. Lloyd Morgan, bionomics by Messrs. J. Arthur Thomson and Norman Wyld, history and principles of the sciences by Prof. Cargill Knott, Prof. Geddes, Mr. Bosanquet, and others, physiology of nutrition by Dr. Louis Irvine, a regional survey of Edinburgh and neighbourhood by Mr. J. G. Goodchild, Dr. Beard, Mr. Robert Turnbull, and Mr. S. H. Capper. A healthy sign is the attention given to practical work; thus the afternoon classes of botany, zoology, and geology were wholly practical. The less strictly scientific part of the month's miniature curriculum shows an almost equal development, indeed, so many excellent subjects were offered to the students that it must have been difficult to choose a course of study. Whatever the course selected, however, there is no doubt that the students derived considerable benefit from it.

THE following list of successful candidates for Royal exhibitions, national scholarships, and free studentships, has been issued by the Department of Science and Art:—National Scholarships for Mechanics—William Buchan (Glasgow), Frederick C. Lea (Crewe), James Eagles (Bury, Lancashire), Richard H. Cabena (Glasgow); National Scholarships for Chemistry and Physics—Albert Howard, (Much Wenlock, Salop), Francis R. Penn (Northampton), Andrew N. Meldrum (Aberdeen), William A. Bradley (Lee, Kent), Robert H. Jones (Manchester); National Scholarships for Biological subjects—Arthur O. Allen, (Walthamstow), Robert Sowter, (Brighouse, Yorks); National Scholarships—Charles F. Smith (Glasgow), John B. Chambers (London), John W. Hinchley (Lincoln), Henry J. Loveridge (Southsea, Portsmouth), Bernard C. Laws (Southsea, Portsmouth), Henry T. Davidge (London), Joseph B. Butters (Brighton), Henry H. Clements (Anahilt, Co. Down), Christopher Oathett (Burnley), William Macdonald (Manchester), William N. Platt (Chester); Royal Exhibitions—George S. Blake (Manchester), William H. Atherton, (Newcastle-on-Tyne), Ernest H. Bagnall (Manchester), Frank H. Newman (London), William A. Taylor (Crewe), Joseph H. Ivey (Camborne), Joe Crowther (Brighouse, Yorks); Free Studentships—John Schofield (Huddersfield), Joseph Jeffery (Birmingham), George A. Robertson (Oldham), Charles Kelly (Belfast), John Robinson (Belfast), Edmund F. W. Mondy (London).

SCIENTIFIC SERIALS.

American Journal of Science.—August.—We notice the following papers:—The use of cupric nitrate in the voltameter, and the electro-chemical equivalent of copper, by Frederick E. Beach. Copper nitrate solution of density 1·53 possesses certain advantages over the sulphate in voltameters. It is best to add one drop of saturated NH_4Cl solution. The dependence of the amount of copper deposited upon the current density does not appear until a density of 0·25 ampères per sq. cm. of electrode is reached, and then it is counteracted by adding more NH_4Cl. With the nitrate, the weight of copper deposited is practically independent of the temperature between 10° and 35°. The solution may be used a number of times. The equivalent of copper as determined from the nitrate voltameter agrees to four figures with that calculated from the best chemical determinations. But it is essential that the solution should be pure, and especially free from traces of nitrite.—On Mackintoshite, a new thorium and uranium mineral, by Wm. Earl Hidden; with analysis by W. F. Hillebrand. This is the original mineral of which thorogummite, discovered in 1891, is the alteration product. It is an opaque black mineral of hardness 5·5, and resembles zircon and thorite in form. It differs from thorogummite by the further oxidation of the uranium and the assumption of one molecule of water. It contains three molecules of silica, one of urania, three of thoria, and three of water.—On the reduction of nitric acid by ferrous salts, by Charlotte F. Roberts. The volume of nitric oxide disengaged, swept along by carbon dioxide and collected over caustic soda, was measured for the estimation of nitrates. The best results were obtained by passing the gas through KI solution before collecting, and estimating from the total volume of gas collected. Nitric oxide, being slightly soluble in caustic soda solution, must not be left long in contact with it. When the reaction takes place at high temperatures, some higher oxides of nitrogen may be formed, but this is corrected by the KI solution.—Concerning the struc-